DETAILS OF THE WEATHER IN THE UNITED STATES.

GENERAL CONDITIONS.

The weather of the month, on the whole, was close to the normal for May. Atmospheric pressure was high on both coasts and for quite a distance into the interior, thus indicating oceanic control and the development of more than the average number of cyclonic disturbances in the Rocky Mountain region and the South. The movement of these in turn resulted in high temperatures generally east of the Rockies. To the large number of cyclones passing across the Southwest may be attributed the heavy rains of the Gulf States, including Florida.

An example of extreme weather conditions in May is found in the 48-hour snowstorm in the mountains of Colorado, New Mexico, and southern Utah on the 8th and 9th. This storm, after passing over the plains States, caused heavy snow in the mountains of South Dakota and tornadic storms locally in Nebraska.

The usual details follow.

CYCLONES AND ANTICYCLONES.

By W. P. DAY, Observer.

Cyclonic areas were numerous, but few developed storm intensity. A majority of them appeared to form over the southern portion of the country and moved slowly north and northeastward.

Only one Alberta anticyclone was charted, while five of the Hudson Bay type and seven offshoots from the North Pacific anticyclone were noted. With one exception the latter were not well defined except on the immediate Pacific coast. As a rule, high pressure on the Pacific on reaching the coast extends inland as a lobe which later separates from the oceanic high pressure and passes to the east of the Rocky Mountains, the oceanic anticyclone meanwhile apparently retreating to the westward. These offshoots are generally weak during the warmer months and reach the Atlantic with difficulty.

LOWS.	Alberta.	North Pacific.	South Pacific.	Northern Rocky Mountain.	Colorado.	Texas.	East Gulf.	South Atlantic.	Central.	Total.
May, 1922	3.0	.....	1.0	1.0	3.0	3.0	4.0	.....	3.0	18.0
Average number, 1892-1912, inclusive	2.9	1.3	1.2	0.7	1.4	0.7	0.2	0.3	1.0	9.7

HIGHS.	North Pacific.	South Pacific.	Alberta.	Plateau and Rocky Mountain region.	Hudson Bay.	Total.
May, 1922	7.0	.....	1.0	.....	5.0	13.0
Average number, 1892-1912, inclusive	1.3	0.5	3.3	0.7	0.9	6.7

FREE-AIR CONDITIONS.

By W. R. GREGG, Meteorologist.

Mean free-air temperatures for the month (Table 1) did not differ greatly from the normal, being slightly below at Drexel and above at all other stations. The greatest positive departures occurred at Royal Center, in agreement with the conditions shown in Climatological Chart III, viz, abnormally high temperatures in the States adjoining the Great Lakes. Elsewhere throughout the country there was little variation from the normal. At Royal Center the departures were less in the upper levels than at and near the surface—a condition that is usually found, viz, a greater tendency on the average to maintain a steady state in the free atmosphere than in the region below 2 or 3 kilometers.

There were no unusually high or low temperatures at any of the stations. In general the individual variations from the monthly mean were less than 5° C.; in no case were they as large as 10° C.

Relative humidities were for the most part slightly above normal; decidedly so in the extreme upper levels at Broken Arrow. There were no extended periods of exceptionally dry conditions at any of the stations.

Vapor pressures were generally above the seasonal average in conformity with the positive temperature departures. The excess was greatest at Royal Center; at Drexel there was little variation from normal conditions.

In Table 2 may be found the resultant winds for the month at the six kite stations and, for the sake of comparison, the normal values. In general there was a stronger south component than usual. Particularly was this true at Royal Center, where, it will be recalled, temperatures were abnormally high. At Drexel, on the other hand, the south component was comparatively weak and the temperatures, as previously stated, were somewhat below normal. Resultant speeds did not differ greatly from the normal at any station or at any altitude.

High winds, 30 m. p. s. or over, were observed as follows:

[By means of kites.]

Station.	Date.	Direction.	Velocity.	Altitude.
			M. p. s.	*Meters.*
Drexel, Nebr.	6	nw.	31	2,200
Due West, S. C.	19	wsw.	40	2,900

[By means of pilot balloons.]

Broken Arrow, Okla.	5	nw.	44	9,200
Do.	13	w.	40	8,500
Do.	20	w.	30	4,500
Burlington, Vt.	8	nw.	31	3,500
Camp Bragg, N. C.	19	wsw.	32	4,500
Denver, Colo.	8	sw.	30	2,000
Drexel, Nebr.	11	sw.	31	600
Do.	12	wsw.	31	2,500
Do.	15	w.	44	8,700
Ellendale, N. Dak.	2	sw.	30	600
Groesbeck, Tex.	3	wsw.	30	7,000
Do.	18	wnw.	34	10,000
Mather Field, Calif.	10	nnw.	31	4,300
Do.	24	sw.	32	6,200
Mitchel Field, N. Y.	8	nne.	35	3,000
Do.	11	n.	46	2,800
Rockwell Field, Calif.	10	nw.	30	5,200
Do.	16	wsw.	36	8,300
Ross Field, Calif.	10	nw.	45	4,800
Washington, D. C.	8	nw.	30	6,500

This table shows that with the approach of summer conditions there is a marked decrease in the number of high winds observed. Weather conditions for the month, as a whole, were unsettled and there were more than the usual number of cyclones, but with three exceptions these were comparatively weak and poorly developed. The one on the 11th to 12th, central in the Dakotas, was by far the most active and best developed during the month. This storm was nearly circular in

form and the pressure gradient in all directions from the center was very steep, the lowest pressure being 29.2 inches on the 11th. It moved slowly from western South Dakota on the 11th to northern North Dakota on the 12th, and was attended by general precipitation. It was most active on the 11th, when high free-air winds, 20 to 30 m. p. s., or more were observed at Ellendale, Drexel, Madison, and Broken Arrow. These winds, and those of lower velocity at other stations in the vicinity of this cyclone, conformed very closely with the sea-level pressure distribution. At Ellendale, for example, the wind was SSE. from the surface to 3 kilometers; at Drexel, S. from the surface to 2,500 meters; at Broken Arrow, SSW. at the surface and SW. in the upper levels; and at Denver, WNW. to W. from the surface to 3,500 meters above it. No observations were made in the northwest quadrant of this storm.

Other cases in which high free-air winds were observed over a considerable section were as follows: On the 8th along the North Atlantic coast in connection with a cyclone central over the Gulf of St. Lawrence; on the 10th along the California coast, when there was a rather sharp gradient of pressure and temperature to the eastward; and on the 18th to 20th in the central and eastern portions of the country during the eastward passage of a very vigorous and well-developed cyclone (lowest pressure 29.12 inches on the 19th at Alpena and Saginaw) from Wisconsin to eastern Ontario.

With the exception of the four cases above cited, air movement during the month was, on the whole, rather sluggish, in line with the weak pressure and temperature gradients. Easterly winds in the higher levels (above 3 kilometers) were observed on several days—5 or 6 on the average for the whole country. They were of widespread extent during two periods, viz, 22d to 24th, when they occurred over the States east of the Rockies, except Texas and Oklahoma; and 27th to 30th, when they were general over all portions of the country except southern Florida. These easterly winds were light, usually between 1 and 5 m. p. s., seldom exceeding 10 m. p. s. Surface weather changed but little during each period. For instance, a moderate cyclone central in eastern Oklahoma on the 22d had moved northward less than 200 miles by the 24th, after which it dissipated; similarly, a cyclone of small intensity but accompanied by considerable precipitation, remained in practically a stationary position just south of Mississippi and Alabama from the 28th to 31st.

On the 29th conditions were especially favorable for high balloon ascensions, because of the light winds and also exceptionally good visibility. The balloon in the morning observation at Royal Center was followed for 3 hours and 9 minutes. The rate of ascent was 180 m. p. m., and this would give an altitude of about 34 kilometers, but, as only one theodolite was used and as the behavior of balloons at great heights is uncertain, this computed altitude can not be accepted with any great degree of confidence. More especially is this true since the indicated winds during the latter part of the observation increased very decidedly in speed—a condition that would result if the balloon, as the result of a leak, ceased to rise. However, a careful examination of the record gives good reason for the belief that the balloon actually reached a height of 20 to 25 kilometers. Although the winds were light at all altitudes, three different circulations were in evidence and well-defined: (1) From the surface to 4 or 5 kilometers the winds were easterly and of low speed, 1 to 3 m. p. s. for the most part; (2) above a calm layer between 5 and 7 kilometers there were northwesterly winds of somewhat higher velocity, 5 to 10 m. p. s., extending to about 16 kilometers; and (3) from this height to about 25 kilometers the winds were northeasterly and light, 2 to 5 m. p. s. Observations at other stations and one at Royal Center in the afternoon of the same day showed good agreement as high up as they extended, viz, an easterly current from the surface to about 5 kilometers, surmounted by northwesterly winds up to at least 12 kilometers, the highest altitude reached.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during May, 1922.*

TEMPERATURE (°C.).

Altitude. m. s. l. (*m.*)	Broken Arrow, Okla. (233*m.*)		Drexel, Nebr. (396*m.*)		Due West, S. C. (217*m.*)		Ellendale, N. Dak. (444*m.*)		Groesbeck, Tex. (141*m.*)		Royal Center, Ind. (225*m.*)	
	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.
Surface..	21.4	+0.9	15.9	−0.7	20.9	−0.1	14.1	+0.4	23.5	+0.5	20.8	+3.
250.....	21.3	+1.0	.....	.....	20.6	0.0	.....	.....	22.9	+.7	20.5	+3.
500.....	19.6	+1.3	15.1	−0.8	18.5	+0.3	13.8	+.5	21.6	+1.2	18.1	+3.
750.....	18.0	+1.4	13.6	−0.5	16.8	+0.5	12.6	+.9	20.4	+1.3	16.2	+3.3
1,000....	16.6	+1.3	12.0	−0.7	15.2	+0.4	11.1	+.9	19.2	+1.4	14.4	+3.1
1,250....	15.0	+1.0	10.3	−1.0	13.8	+0.5	9.5	+.7	18.1	+1.4	12.7	+2.9
1,500....	13.4	+.6	8.9	−0.9	12.6	+0.7	7.9	+.6	17.0	+1.5	11.0	+2.6
2,000....	10.8	+.7	6.9	−0.3	10.6	+1.3	5.1	+.8	14.8	+1.7	8.0	+2.0
2,500....	8.3	+1.2	4.2	−0.2	8.7	+2.1	2.6	+1.3	12.1	+1.7	5.0	+1.4
3,000....	4.8	+.9	1.1	0.1	.....	.....	0.3	+1.8	8.7	+1.2	2.4	+1.4
3,500....	1.8	+.7	−1.9	−0.1	.....	.....	−2.4	+1.7	5.0	+0.8	−0.1	+1.5
4,000....	−1.2	+.7	−4.8	0.0	.....	.....	−5.6	+1.4	1.4	+0.8	−2.7	+1.5
4,500....	.....	.....	−8.2	−0.3	.....	.....	−8.6	+1.2	−2.7	+0.8	−5.3	+1.5
5,000....	.....	.....	.....	.....	.....	.....	−9.9	+1.2	−6.0	+0.8	−8.0	+1.5

RELATIVE HUMIDITY (%).

Surface..	73	−1	70	+5	68	+4	72	+8	78	+3	61	−2
250.....	73	−1	.....	.....	68	+4	.....	.....	77	+2	61	−2
500.....	71	−2	69	+5	67	+3	71	+7	76	+1	61	−3
750.....	70	−3	66	+3	68	+3	69	+7	74	+1	61	−3
1,000....	71	−1	65	+3	70	+5	69	+7	73	+2	61	−2
1,250....	73	+2	65	+3	69	+5	70	+7	68	0	63	+1
1,500....	73	+6	63	+1	68	+4	71	+8	64	−1	64	+4
2,000....	70	+7	55	−4	65	+2	70	+8	54	−2	60	+6
2,500....	66	+7	52	−5	63	0	67	+6	46	−5	55	+8
3,000....	68	+14	51	−7	57	−2	60	0	46	−2	45	+3
3,500....	66	+15	50	−8	49	−3	53	−3	50	+3	45	+6
4,000....	82	+23	49	−10	39	−5	53	−1	49	+3	43	+7
4,500....	.....	.....	50	−11	.....	.....	57	+3	55	+3	41	+7
5,000....	.....	.....	.....	.....	.....	.....	44	+3	.....	.....	39	+7

VAPOR PRESSURE (*mb.*).

Surface..	18.59	+0.58	12.85	+0.39	16.60	+0.68	11.67	+1.61	22.55	+1.76	15.30	+2.65
250.....	18.40	+0.54	.....	.....	16.23	+0.63	.....	.....	21.65	+1.80	14.96	+2.55
500.....	16.10	+0.37	12.10	+0.30	14.06	+0.48	11.35	+1.51	19.73	+1 91	13.07	+2.40
750.....	14.34	+0.23	10.56	+0.09	12.78	+0.43	10.16	+1.57	17.76	+1.82	11.63	+2.17
1,000....	13.47	+0.62	9.39	−0.07	11.83	+0.50	9.17	+1.39	16.09	+1.79	10.55	+2.05
1,250....	12.65	+1.03	8.45	−0.10	10.76	+0.55	8.34	+1.19	13.80	+1.24	9.76	+2.17
1,500....	11.40	+1.33	7.57	−0.09	9.84	+0.55	7.61	+1.13	12.01	+1.04	8.97	+2.27
2,000....	8.99	+1.09	5.74	−0.26	8.20	+0.53	6.08	+0.94	8.84	+0.79	7.08	+2.04
2,500....	6.92	+.98	4.86	+0.07	6.97	+0.60	4.71	+0.73	6.38	+0.23	5.35	+1.73
3,000....	5.71	+1.34	4.19	+0.03	.....	.....	3.56	+0.40	5.20	+0.34	3.72	+1.21
3,500....	4.41	+0.84	3.59	+0.52	.....	.....	2.56	+0.10	4.40	+0.45	2.92	+1.02
4,000....	4.42	+0.96	3.24	+0.70	.....	.....	1.99	+0.04	3.61	+0.31	2.73	+1.40
4,500....	.....	.....	2.98	+0.86	.....	.....	1.63	+0.08	3.23	+0.31	2.53	+1.42
5,000....	.....	.....	.....	.....	.....	.....	1.08	+0.08	.....	.....	2.38	+1.43

TABLE 2.—*Free-air resultant winds (m. p. s.) during May, 1922.*

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (23m.)				Drexel, Nebr. (396m.)				Due west, S. C. (217m.)				Ellendale, N. Dak. (444m.)				Groesbeck, Tex. (141m.)				Royal Center, Ind. (225m.)			
	Mean.		Normal.		Mean.		Normal.		Mean.		Normal.		Mean.		Normal.		Mean.		Normal.		Mean.		Normal.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 4° E.	2.0	S. 19° E.	2.6	S. 52° W.	1.8	S. 2° W.	1.5	S. 62° E.	0.9	N. 58° E.	0.9	N. 75° W.	0.7	S. 55° E.	0.6	S. 12° E.	1.9	S. 18° E.	2.0	S. 5° E.	1.6	N. 58° E.	0.9
250	S. 5° E.	2.1	S. 19° E.	2.6	.....	.....	.....	.....	S. 64° E.	0.9	N. 56° E.	1.0	.....	.....	.....	.....	S. 1° W.	2.9	S. 11° E.	2.6	S. 7° E.	1.7	N. 60° E.	0.9
500	S. 11° E.	2.9	S. 15° E.	3.3	S. 63° W.	2.1	S. 4° W.	1.8	S. 77° E.	0.9	N. 41° E.	1.3	S. 81° W.	0.8	S. 40° E.	0.8	S. 3° W.	4.9	S. 4° E.	4.0	S. 2° W.	2.1	N. 61° E.	0.6
750	S. 9° E.	3.4	S. 4° E.	3.7	S. 87° W.	2.8	S. 8° W.	2.0	S. 82° E.	0.4	N. 20° E.	1.3	S. 54° W.	1.7	S. 19° E.	1.2	S. 15° W.	5.2	S. 4° W.	4.6	S. 17° W.	2.3	N. 9° E.	0.3
1,000	S. 4° W.	3.3	S. 8° W.	3.9	W.	3.0	S. 26° W.	2.6	S. 50° W.	0.1	N. 4° E.	1.5	S. 44° W.	1.8	S. 7° E.	1.0	S. 24° W.	5.1	S. 16° W.	4.6	S. 39° W.	2.7	N. 42° W.	0.5
1,250	S. 25° W.	4.0	S. 24° W.	4.2	S. 86° W.	3.8	S. 34° W.	2.9	S. 39° W.	1.4	N. 30° W.	1.0	S. 53° W.	2.4	S. 7° W.	2.5	S. 35° W.	5.1	S. 23° W.	5.7	S. 48° W.	3.6	N. 46° W.	1.3
1,500	S. 28° W.	4.4	S. 32° W.	4.5	S. 84° W.	4.0	S. 42° W.	3.6	S. 75° W.	3.3	S. 69° W.	1.5	S. 48° W.	3.0	S. 12° W.	2.5	S. 44° W.	5.3	S. 31° W.	5.4	S. 47° W.	3.7	N. 64° W.	1.7
2,000	S. 40° W.	6.0	S. 46° W.	4.9	S. 84° W.	5.3	S. 57° W.	4.7	S. 20° W.	4.0	S. 78° W.	1.6	S. 47° W.	3.4	S. 26° W.	3.6	S. 65° W.	5.7	S. 40° W.	5.2	S. 55° W.	4.8	N. 68° W.	2.6
2,500	S. 52° W.	6.6	S. 60° W.	5.4	N. 85° W.	7.1	S. 65° W.	5.2	S. 43° W.	4.6	S. 85° W.	2.1	S. 34° W.	4.0	S. 33° W.	5.1	S. 83° W.	8.2	S. 55° W.	5.5	S. 44° W.	4.2	N. 66° W.	3.3
3,000	S. 58° W.	7.7	S. 74° W.	5.6	N. 89° W.	10.7	S. 72° W.	7.3	S. 56° W.	1.9	N. 33° W.	2.5	S. 23° W.	5.3	S. 42° W.	6.9	S. 67° W.	8.4	S. 59° W.	6.5	S. 29° W.	1.0	N. 56° W.	3.5
3,500	N. 77° W.	8.8	N. 81° W.	8.2	S. 88° W.	13.0	S. 78° W.	8.0	W.	7.1	N. 57° W.	6.0	S. 17° W.	5.1	S. 50° W.	6.3	S. 64° W.	9.8	S. 63° W.	8.8	N. 17° W.	1.0	N. 46° W.	4.9
4,000	N. 47° W.	7.8	N. 55° W.	11.5	N. 82° W.	16.8	N. 88° W.	8.7	N. 79° W.	14.0	N. 48° W.	7.8	S. 20° W.	6.1	S. 77° W.	6.6	S. 80° W.	13.6	N. 88° W.	12.4	N. 14° W.	3.3	N. 73° W.	6.7
4,500	.....	.....	.....	.....	N. 73° W.	19.0	S. 68° W.	10.0	.....	.....	.....	.....	S. 22° W.	5.9	N. 2° E.	1.1	N. 88° W.	17.3	.....	.....	N. 14° W.	3.3	.....	.....
5,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	S. 14° W.	5.6	N. 53° W.	8.4	S. 86° W.	17.4	.....	.....	S. 66° W.	1.2	.....	.....

THE WEATHER ELEMENTS.

By P. C. DAY, Climatologist and Chief of Division.

PRESSURE AND WINDS.

The atmospheric circulation during May assumed to a considerable extent the flattened system of isobars common to the summer season, and there was a very general slacking up of the cyclonic and anticyclonic activity that had been a rather marked feature of the weather during several months preceding.

The anticyclones had their origin mostly over the southwestern districts and drifted northeastward or eastward, usually without definite centers of action. However, near the end of the first decade low pressure developed over the middle Rocky Mountain region, and pressure remained low in that vicinity for several days, finally developing into a storm, which by the morning of the 11th had assumed definite form, central over western South Dakota. More or less precipitation occurred in the western mountain and adjacent districts during the formation of this low area, and general rains accompanied its northward movement over the Dakotas into the Canadian districts during the following few days. The falls were particularly heavy in the Black Hills region and locally elsewhere in the Dakotas and portions of adjoining States. During the early formative period of this storm heavy snows fell in southwestern Colorado and adjacent portions of Utah and Arizona, the fall in southwestern Utah being the heaviest ever recorded in May. Light snow extended over considerable areas, particularly to the westward, reaching Roseburg, Oreg., where it was observed in May for the first time in nearly 50 years.

During much of the first and second decades pressure remained comparatively low over southern districts, and local rains, heavy in many localities, persisted for considerable periods, particularly in the Gulf and South Atlantic States and over portions of the Ohio and middle Mississippi Valleys. By the morning of the 18th low pressure had concentrated into a trough formation extending from the upper Mississippi Valley southeastward to the Carolinas, and during the following 24 hours assumed a definite cyclonic formation central over the lower Lakes. This was attended by general precipitation from the Mississippi eastward, the falls becoming heavy locally near the storm center. This storm quickly lost force, however, and passed down the St. Lawrence Valley without material precipitation.

During the last decade of the month shallow cyclones moved in irregular courses over the central valleys and southern districts, and precipitation was frequent and locally heavy over much of the country from the middle and southern Great Plains eastward.

Anticyclones moving southward from the Hudson Bay region dominated the northeastern districts during much of the month, while in the far Northwest offshoots from the permanent high area over the North Pacific reached the coast on a number of dates, but usually did not materially influence weather conditions to eastward of the Rocky Mountains. In the region between the Great Lakes and Rocky Mountains and thence southward there was a notable absence of anticyclones, particularly of those frequently moving southward from the Alberta district.

For the month, as a whole, pressure was highest and materially above normal over the far Northwest, with a secondary high area over the Northeastern States, where the average pressure was likewise appreciably above normal. Over the central valleys and southern districts the average pressure was comparatively low and generally somewhat less than normal.

Compared with the preceding month the pressure was less in all districts save the extreme Northeast, the falling off being quite large over the southeastern States and along the California coast.

Winds over the districts from the Mississippi Valley eastward did not reach high velocities, as a rule, save in connection with local thunderstorms, which were widely scattered both as to location and time. On the other hand, over the Great Plains and thence westward high winds were confined mainly to definite localities and dates. Over the middle and northern Great Plains and the adjacent eastern foothills of the Rocky Mountains high winds prevailed over large areas in connection with the well-developed cyclone that moved northward over those districts on the 10th and 11th. Also in the Plateau region high winds prevailed over extensive areas on the 25th. A more complete statement of the severe storms of the month appears at the end of this section. The prevailing direction of the winds is graphically shown on Chart VI.

TEMPERATURE.

In the absence of important changes in atmospheric pressure, daily temperature variations were likewise small, 24-hour changes of 20° or more occurring in only a